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EDITORIAL

The World Wheat Agreement

AN agreement has recently been concluded between the governments of Germany, Austria, Belgium, Bulgaria, France, the United Kingdom, Greece, Hungary, Irish Free State, Italy, Poland, Rumania, Spain, Sweden, Czechoslovakia, Switzerland, Russia, Yugoslavia, Argentina, Australia, Canada, and the United States, providing for a restriction of the acreage of wheat grown and of the export of wheat. The governments of Argentina, Australia, Canada, and the United States agree in the main to a reduction of fifteen per cent. in the export of wheat : the governments of Bulgaria, Hungary, Rumania, and Yugoslavia agree that their combined exports of wheat will not exceed fifty million bushels; a Wheat Advisory Committee is to be set up to watch over the working and application of the agreement. The text of the agreement will be found in *The Times*, and probably other papers, of August 26th. It seems to us that the conclusion of this agreement is an event of supreme significance and importance. The nations of the world have during the last few years been engaged in considering the great economic questions from two points of view, the one to find some solution that will benefit a particular country at the expense of all the other countries, the other to find a solution for the benefit of the world at large, in which the individual countries will all participate. Broadly speaking tariffs belong to the first category and international agreements for regulating production, export, and prices of a commodity belong to the second. No doubt other examples might be given and the problem is not of course quite so simple as we have stated, but in the main there has been a conflict between selfishness and altruism in which usually selfishness has prevailed. We are not using these terms as implying any blame or praise, but merely as indicating what may be considered the insular and the international points of view. We, living in this small island, might be expected to be very insular, but our relationship with the dominions and colonies with which we are imperially connected makes us much less insular than most of the continental republics. Russia and Germany are both engaged in an effort to build up a splendid isolation and each country may, or may not, succeed in persuading the world at large that it is more noble, more purely bred, more patriotic, more prudent, more honest, more just, more considerate, and more cultured than any other country. In this country we have so long been satisfied that we possess all these good qualities, and all the others, to the maximum extent that we do not trouble to advertise the fact or sing about it or attempt any sort of propaganda in connexion with it ; we merely know it ourselves and assume that everyone else knows it ; nor do we care a jot if all the other nations have an equally conceited or perhaps an equally erroneous opinion of their own characteristics. From our lofty standpoint we can with complacency and satisfaction look on the plains and the near and distant hills and if some of these distant hills are really more exalted than our own they do not seem so to us and therefore all is well. This pride in ourselves, tempered with a small measure of cynicism and a partial recognition of our hypocrisy, is our national outlook. If the other nations do not take us at our own valuation we shall consider that though we may have a little overstated our virtues and underestimated our faults we need not be unduly troubled because the Italians, the French, or the Germans are so misguided as to consider themselves as good or, *mirabile dictu*, even better. The pride of race, the necessity of protecting the industry in which one's own people are engaged, and the need to balance the national budget are sufficiently powerful to ensure that the insular or selfish point of view will receive due consideration. It is not so obvious that the international point of view will have its fair share of encouragement. During the last few years we have in these columns on several occasions called attention to the benefits derived from international agreements regulating production and prices and we believe that the time has already come when many industries can prosper only if such international rationing can be made effective. It seems a foolish thing that the production of wheat, or coffee, or tin, or copper, or quinine, or stockings, or wireless apparatus, or mutton, should be so little regulated that a large number of those engaged in the production cannot make a profit or afford to pay a living wage. Men of science have, so far as competition is concerned, effected a greater change than Einstein ever imagined ; they have practically eliminated time and length from their dimensional system. The farmer who grows a few acres of oats in north Devon feels the competition of oats grown a few thousand miles away more severely than that of the oats grown in the next parish. We do not know the details of the various successful attempts to regulate the prices of important commodities but it is fairly well known that soda is adequately controlled and has been for thirty years; some other items of the heavy chemical industry have long been controlled ; there is a very important regulation of dyestuffs ; steel rails, linoleum, sundry lead compounds, and a great variety of other things are

wholly or partially rationed and in our opinion—which we do not consider infallible—much more of such regulation must be achieved before the world can again become prosperous. We can remember the time when such attempts to make production equal demand were looked upon with much disfavour, when American public opinion was strongly opposed to such monopolistic enterprises, when the finger of scorn was pointed at Sir John Brunner and Sir Alfred Mond as professed free-traders battening on a water-tight rationing scheme, when governments of all kinds looked with disfavour on such wickednesses. The interesting thing about the present agreement is that it deals with the greatest of all commodities in importance, so far as several countries are concerned, that it has been brought about not by secret meetings of greedy individuals, but by the governments themselves, and that the governments include Russia, Germany, Canada, the United States, and others to whom such a policy is a welcome and not unexpected change. This agreement will, if successful, be the greatest achievement of international socialism ever attempted; so far as this country is concerned it has been carried out by a government returned with a greater anti-socialistic bias than anyone can remember. We do not suppose that any socialist or anti-socialist objects to the agreement for that reason alone. Those of us who are individualistic in our outlook, as a rule object to socialistic experiments in industry because they are carried on by inexperienced people and are unsuccessful. We are, some of us, timid about leaving our own government in direct charge of the production of commodities; we know how costly government control is, how wasteful and shocking it was during the war. The governments of most of the countries who are parties to this agreement will take no part in the production of wheat; they will neither buy the seed nor send an inspector to watch the sowing; they have organised the international agreement; we sincerely hope that it will be successful; if it is we expect the principle will be speedily and widely extended; if so our belief is that in five or ten years the world will be much happier than it is now.

Authors and Editors

There are many small points of traditional usage that are practised by experienced printers and should be known by conscientious editors, but are of no importance or interest to authors in general. For instance advertise is spelled with an s, but equalize with a z; bogey in golf is spelled with an e, but bogy, an apparition, without an e, and bogie, a truck, differs from the other two. Hymn-book has a hyphen but post office has none; aide-de-camp is printed in roman type: so is vice versa, but *sotto voce* and *pro forma* are printed in italic. For some reason that we do not know the common usage is to write a history but an historical account. We write Queens' College, Cambridge, but St. John's Wood and St. Helens and St. Davids. We should write and print northern England but Western Australia. The wise write *The Times* but the *Daily News*. There is a diversity of opinion whether we should write viz or viz., but it is considered correct to print it, whether with or without the full stop, in roman type. Many books have been written about these niceties and about punctuation, and few of us need trouble to learn the elaborate, artificial, and illogical rules laid down by the learned in these matters. On the other hand, there are one or two rules, half a dozen maybe, that authors should try to observe. Of the various small mistakes that come before our notice far the commonest are those that transgress the rules that a singular noun agrees with a singular verb and a plural noun with a plural verb. English as spoken and written by educated people at the present time is possibly more elastic in its rules than Latin was in the time of Cicero but the particular rules that we have mentioned are broken so commonly in the manuscripts that we peruse that it seems to be worth while to refer to them in some detail. These rules are very frequently broken in articles in some of our newspapers and stories in some of our magazines but what is tolerable in these is intolerable in accurate articles by learned people, whose writings will go down to posterity. As a rule in such a statement as 'iron is an element,' the first noun is taken to be the subject of the verb and governs its number; you must not say: 'our only guide to the time are the hands of the clock' but 'is' and if this seems to be awkward then the sentence must be altered so as to run 'the hands of the clock are our only guide' or some other transposition effected. The last few days of our holiday are a pleasant time and the last few years of chemistry are an age, or an epoch, of astounding activity. Series may be either singular or plural but a series is singular and a series of experiments physical, chemical, and biological, has greatly advanced our knowledge of biochemistry during that period; a mass of important facts and of unimportant conjectures has been accumulated, not have been. If the facts and theories of chemistry are as Armstrong, or Bancroft states we may assume that our grammar is correct although Armstrong and Bancroft may not speak in identical terms. And if we do not like the style of the sentence we can re-write it and avoid any harshness. A knowledge of the experiments of Victor Meyer and Gay-Lussac and of the writings of Hofmann and Bunsen is necessary to a due appreciation of the work of Baeyer not are necessary; this sort of error is so common in documents that we have seen that we fear it may occasionally have escaped detection and found its way into—not in to—our pages. In dealing with collective nouns such as crew, company, committee, ministry, or university, if we are speaking of a company or a university as a unit it is better to use the singular; if we speak of one of these bodies as a collection of units it is better to use the plural. Thus we print 'the company has declared a dividend,' and 'the university has published a book' but the 'government are all divided among themselves' and 'the board of examiners have lost their heads.' Chemists familiar with atoms and molecules will have no difficulty in applying the principle. We assume that all our readers and writers know that the word 'data' is plural and the word 'propaganda' is singular and so we need not waste space over these and such elementary points. Whether 'for ever' is one word or two has been referred to by Calverley; we do not remember who it was who debated whether soda water was one word or two connected by a syphon, but the best modern usage is to write it 'soda-water,' and to pronounce it 'splash.'

THE DETERMINATION OF MOLECULAR WEIGHT OF LINSEED OIL AND ITS POLYMERIDES

By P. J. GAY

The determination of the molecular weight of fatty oils has long presented difficulty owing to the variableness of the results generally obtained by standard cryoscopic and ebullioscopic methods. The former method is usually preferred. The molecular weight obtained cryoscopically is given by the formula: $M = \frac{KC}{\delta}$ where K is the calculated depression of the freezing point produced by 1 g. molecule of any solute in 100 g. of solvent, C is the concentration of solute in grams per 100 g. of solvent and δ is the observed depression of the freezing point.

It has been generally observed that there are considerable variations in the molecular weight figures obtained cryoscopically for fatty oils according to the solvent and concentration used, although these are always in the category of dilute solutions. The figures are usually wide of the theoretical value. It is understood that the term molecular weight implies the mean molecular weight of the components of the oil. Solvents used are camphor (Rast's method), benzene, nitrobenzene, ethylene-dibromide, etc. Bauer (Farben Ztg., 1926, **31**, 2130—1) states that the discrepancies between the values obtained in different solvents can be explained on the principle of association of solute molecules, and as examples, quotes that in camphor solution oil molecules are monomolecular, while in benzene they are bimolecular. On the other hand the lowering of the observed molecular weight with increasing concentration in benzene solution is not consistent with principles of association and it is suggested that the variation in values obtained is due to reactivity with or solvation of the solvent (Seaton and Sawyer; J. Ind. Eng. Chem., 1916, **8**, 490: Friend and Alcock, J.O.C.C.A., 1924, **7**, 146—152: Morrell, *ibid*, 1924, **7**, 153—160). Neither of these theories, however, appears to be sufficient to explain the abnormally low results often obtained for fatty oils, especially at higher concentrations, since any association phenomenon involving the solute is bound to produce abnormally high results. Seaton and Sawyer (*loc. cit.*) tried several solvents and obtained the most favourable results using stearic acid. Working with concentrations ranging from 3·8% to 10·2% they found little variation in the observed molecular weight for raw linseed oil, but values were well below the theoretical, being of the order 735—760. The theoretical mean molecular weight of linseed oil lies in the region 872—890. In benzene solution values from 930 for concentration 0·593% to 740 for concentration 8·45% were obtained. Nitrobenzene, a non-associating solvent, was found to give rather better results than benzene, and very great variation was observed using chloroform as an ebullioscopic solvent.

Long and Wentz (J. Ind. Eng. Chem., 1926, **18**, 1245—8) have examined a range of solvents giving various values for molecular weights of linseed and tung oils, these usually being lower than theoretical. They favour benzene as solvent but stress the importance of working at constant concentration in order to obtain reproducible results. This has been adopted as a method of control for the boiling of oils (Long and Smull, J. Ind. Eng. Chem., 1925, **17**, 138—141). The figures obtained are purely arbitrary and have no theoretical significance at all. Long and Wentz (*loc. cit.*) attribute the low figure (720) obtained for the molecular weight of linseed oil to the presence of mono- and di-glycerides in the oil. This view seems unreasonable in view of the fact that such an oil would have an acetyl value of 14, far above the maximum value observed for linseed oil. It is possible, however, that there is an amount of glycol (*e.g.*, trimethylene glycol) ester present, though it has never been found in any considerable quantity. It is nevertheless much more reasonable to assume that discrepancies which arise are due to peculiarities of the solute or solvent. Mlle Roy (Compt. Rend., 1932, **194**, 1356—8), investigating the molecular weight of samples of castor oil has found the irregularities are largely produced by small quantities of water due to incomplete drying of the oil. Nevertheless, it is found that with all solvents used, there are variations with concentration, particularly abnormal results being obtained with benzene and nitrobenzene. It is claimed that a true value for the molecular weight is obtained by expressing the molecular weight at each concentration as a function of depression of freezing point and extrapolating to zero concentration. This is in direct opposition to Friend and Alcock (*loc. cit.*) who extrapolated to 100% concentration for linseed oil. Acetophenone was found to be the best solvent as it gave a straight line of slight inclination.

Attempts have been made in this laboratory to obtain molecular weights which can be given some theoretical interpretation and the solvents initially tried were benzene, nitrobenzene, ethylene-dibromide and acetophenone. Results for benzene and nitrobenzene were in full agreement with published figures, being of the order 720—740. The cryoscopic constant obtained for nitrobenzene, using benzoic acid as solute, was 41·8, and this gave the molecular weight of a sample of thoroughly dried refined linseed oil of low acid value ($<0{\cdot}5$) as 445. The accepted constant for nitrobenzene is however 69·5 and, using this figure, a molecular weight of 740 was obtained at approximately 2% concentration. Ethylene-dibromide was not persevered with as it was found to be extremely difficult to obtain a sufficient degree of purity to get a really sharp freezing point. It is essential to obtain a very sharp freezing point over a range not greater than 0·003° since at normal concentrations depression is very small on account of the high molecular weight of linseed oil and its polymerides.

Acetophenone was similarly tried and in this case it was found that there was a pronounced disadvantage on account of the supercooling effect prior to freezing. The original material was of supposedly high quality, but was further purified by distillation and was recrystallized and filtered eight times. A maximum freezing point 19·5° C. was obtained. The published figure is 20·8° C. It was found that the freezing point of this solvent steadily dropped. Thus in the course

of 16 minutes the reading on a Beckmann thermometer scale dropped gradually from 6·110° to 6·030° and *overnight the freezing point of the same material* had fallen to 5·600° on the scale. Two days later this same sample had a freezing point of 5·210° on the Beckmann scale. In another instance while trying to get duplicate values of the freezing point the readings on one sample fell 0·127°. It was found that when the material was kept in a dark brown bottle, or when the bottle was enclosed in a lightfast tin, the depression in the freezing point was less marked. It was therefore *concluded that there was a continual change taking* place in the acetophenone and that this change was photocatalytic. It is suggested that either the substance decomposes, or more probably that a tautomeric transformation takes place from the keto to the enol form thus:

$$C_6H_5CO{\cdot}CH_3 \rightarrow C_6H_5C(OH):CH_2$$

and that the two forms exist together as an equilibrium mixture in *which the ketone greatly predominates.* Recrystallization removes the enol body which is then reformed on standing. On account of this gradual depression of freezing point acetophenone is useless as a cryoscopic solvent, and the observations of Mlle Roy (*loc. cit.*) could not be confirmed. There appears to be no mention in the literature of this particular tautomerism, but the reduction of acetophenone to phenyl methyl carbinol by nascent hydrogen lends support to the view that the enol form exists, the reduction taking place as follows—

$$C_6H_5C(OH):CH_2 + 2H \rightarrow C_6H_5CHOH\ CH_3$$

The peculiarities of the solvent appear to be a considerable factor in the determination of the apparent molecular weight of oils. In view of the fact that neither the theory of association of the solute molecules nor reaction between solute and solvent completely explains all discrepancies, it was considered possible that the oil exists in a completely dissociated state and that it is the condition of the solvent at its freezing point which determines apparent molecular weight. *That is to say the state of association of the solvent* molecules may be completely altered by varying concentrations of the oily solute, this in turn affecting the cryoscopic constant and the apparent molecular weight. This theory is capable of being adapted to instances of increasing apparent molecular weight with increasing concentration or vice versa, according to the solvent used. Thus it is suggested that the addition of oil helps to break down the associated benzene *molecules, thereby lowering the cryoscopic constant* and the observed molecular weight. On the other hand its effect on nitrobenzene, which contains a highly reactive nitro-group and whose viscosity suggests a somewhat different state of association, is much smaller and is in fact in the reverse direction.

Extending this principle it was thought that a chemically and physically inert substance of suitable properties should provide the ideal solvent. Such a substance would have no valency stresses likely to cause association with similar molecules or with the solute, and no chemically reactive group. Cyclohexane exactly fulfils these requirements, being similar to the paraffins in properties, and in addition it is an excellent solvent for both untreated and thickened oils, and has a convenient and sharp freezing point of about 5·5° C. It crystallizes to a semi-waxy material and unless it is stirred continuously tends to congeal at the sides of the vessel. The solvent was purified, first by distillation after drying over calcium chloride, and then by repeated recrystallization. After 5—6 recrystallizations it was again dried over calcium chloride and was ready for use. Later batches have been first shaken with concentrated sulphuric acid to remove traces of cyclohexanol, a process which saves one or two recrystallizations and gives a better yield. It froze sharply within 0·001° C. and suffered little from supercooling.

The cryoscopic constant was determined with naphthalene as solute in concentrations varying from 0·1%—1·2%. Naphthalene was chosen on account of its being a reasonably inert substance having no reactive groups likely to cause association and being easily obtained in a pure state. There was no change with concentration in the value of the constant, all the results agreeing within the limits of experimental error as follows:

Concentration %	Constant
0·120	213·5
0·238	212·0
0·790	213·0
1·24	211·3
mean	212·5

This high value for the cryoscopic constant is a decided advantage as it allows appreciable depressions in the freezing point with relatively small concentrations of oil, a factor which becomes of great importance when dealing with the more highly polymerized substances.

An attempt was made to obtain a theoretical value for the molecular weight of stearic acid, but this substance appeared to be only slightly soluble and a cloudy solution resulted, the molecular weight observed being 341 Linseed oil is completely soluble and gives clear solutions at all concentrations. Initial experiments were performed with an acid-free sample dried for several days over phosphoric anhydride in a vacuum desiccator There was no variation of molecular weight with concentration and the figure obtained was within the limits assigned to the theoretically possible value. The undried oil gave a slightly lower value, and the molecular weight of another sample of ordinary commercial refined linseed oil was within theoretical limits. The values obtained were as follows:

	Concentration %	Mol. wt.
Dried acid-free linseed oil	6·3	879
,, ,, ,, ...	2·35	880
,, ,, ,, ...	4·7	876
Same oil undried	5·12	867·5
Commercial linseed oil	3·5	878

The same method has been applied to the measurement of mean molecular weight of polymerides of the last-mentioned linseed oil, and here again there is no variation with concentration. As instances of this, one sample gave identical values of 1263 in concentrations 1·66%, 3·27%, and 4·65%. Another sample, much

highly polymerized, gave a molecular weight .· 1748 for 2·2% concentration and 1760 for 3·3% ·ntration. These values are constant within the ıs of experimental error. The method has been ·.d satisfactorily to oily polymerides of molecular ;ht as high as 4320, but with these very viscous ·ances the manipulative difficulties render the nation less accurate and it is doubtful whether lts can be guaranteed within 3%—5%.

nce neither the observed molecular weight of the nal oil nor of the polymerides varies with concen- ion. and since the former is equal to that theoretically ·ted, it is reasonable to assume that the values ined for the polymerides are correct and are capable heoretical interpretation. It must be remembered t the values obtained represent the mean of many stituents. It is thus shown that an inert, molecularly trained solvent such as cyclohexane gives normal ies for the molecular weight of oils. It is also indi- d that the conditions of both the oil and solvent are ffected by contact with varying quantities of the other stance and that both are therefore in a stable, and umably completely dissociated, condition. This is refore the normal molecular state of linseed oil and tact with other solvents cannot dissociate it further. · discrepancies in values usually obtained must refore be due to changes in the state of association the solvent used. Solvation may be a complicating or of secondary importance when active solvents used. The same reasoning applies to the polymerides l shows that the building up of large colloidal aggre- es during heat thickening is fundamentally a chemical ier than a physical association phenomenon. Poly- ides have definite composition and molecular weight. s is a fact of supreme importance in the study of kened oils.

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ASTICS—CELLULOSE ESTERS AND ETHERS AND THEIR USES*

By Dr. W. J. JENKINS

Ve are familiar with cellulose in many forms. Its standing use is in the textile industry in the form of ton. An estimate of its value in other directions is ained by reference to its use in paper, celluloid, ficial silk, moulding powders, and photographic 1. For some of these purposes chemical derivatives ellulose are required.

A special property of cellulose, which makes it ractive in the above connexions, especially in the tile industry, is its tensile strength, which is of the ie order as that of good quality steel, being greater n that of metals, such as copper, iron, and aluminium.

Lecture given at the Plastics Exhibition, Science Museum, don, S.W., on June 14, 1933.

It has been established that the cellulose fibre is built up of chains of molecular units of $C_6H_{10}O_5$. It can be calculated that there are several hundred millions of these chains in a cross section of a good quality fibre. The interlocking of the chains, together with the chemical forces involved, account for the high tensile strength of cellulose.

Cellulose does not soften under the influence of heat or pressure. Under a sufficiently high temperature it disintegrates into various by-products. Cellulose, therefore, is neither plastic nor thermoplastic. Certain derivatives of cellulose behave differently from the parent material when subjected to heat and pressure. There are available commercially cellulose nitrate, cellulose acetate, and benzyl cellulose, each of which becomes softer as the temperature is increased and if suitably modified will take up a required form quickly when pressed at moderately high temperatures. When the temperature of these cellulose derivatives is again brought back to normal the materials are just as hard as they were at the beginning. This change of plastic condition can be carried out a number of times without any marked effect on the materials. Such products are said to be thermoplastic. It is in this behaviour of certain cellulose derivatives that the cellulose plastics industry has been built up.

Cellulose nitrate or nitrocellulose is usually associated in our thoughts with explosives. The type of nitrocellulose used for the manufacture of the latter obtains its explosive properties mainly from its high nitrogen content. Industrial nitrocellulose differs considerably in that it is of a lower degree of inflammability: it can be used safely as a plastic material, and with certain modifying agents its inflammability is of a relatively low order.

Since 1910 the use of cellulose acetate in the manufacture of plastics has become very important, notably in the manufacture of artificial silk. A secondary development has been in the use of cellulose acetate as a base in the manufacture of thermoplastic moulding powders. Cellulose acetate like nitrocellulose is an ester of cellulose. It can be manufactured either from cotton or from wood pulp. The reaction is carried out by treating cellulose with acetic anhydride and acetic acid in the presence of a catalyst. In course of its preparation the cellulose acetate is precipitated and finally thoroughly washed to remove all traces of the reacting agents which have a deleterious effect on the stability of the product.

More recently there have been considerable developments in the manufacture and use of benzyl cellulose. This product is representative of the ether class of cellulose derivatives. It can be prepared from cotton cellulose or from wood pulp. The first step is to convert the cellulose into soda cellulose by treatment with alkali of mercerizing strength, that is, with soda of about 18% concentration. The length of this treatment and the temperature are controlled very carefully. Benzyl chloride is then added and further reaction carried out at about 100° C. The duration of this reaction and the temperature are again very carefully controlled as the degree of etherification and physical properties of the product are dependent on these factors. Satisfactory

purification is then obtained by thorough washing with water and with certain organic liquids, after which the cellulose derivative is dried and is ready for use in this condition.

The three cellulose derivatives referred to above are typical of the products which can be obtained from cellulose. An idea of the degrees of variation that is possible in properties can be illustrated further by reference to certain classes of compounds made from cellulose. Reference is made first to the class known as the fatty acid esters of cellulose. These are represented by the acetate, the butyrate, the laurate, and the stearate, in which the ester radicle increases in molecular weight as we proceed from the acetate to the stearate. The properties of cellulose esters which come into prominence with regard to their use in plastics are: tensile strength, elongation, temperatures of softening, hygroscopicity, and permeability to water vapour. Investigations of the above class of derivatives have established that the tensile strength decreases as the molecular weight of the ester radicle increases and it has been shown that the tensile strength of the stearate is approximately one-twentieth that of the acetate, while the percentage elongation is around 20 for the acetate and greater than 140 for the stearate.

Cellulose esters and ethers, as at present prepared, do not possess a sharp softening point but become soft over a wide range of temperatures so that while referring to their softening temperature it is often useful to specify the test by which their measurement has been carried out. The temperature of softening of the fatty acid esters of cellulose decreases in the order in which these materials are referred to above. Similarly the hygroscopicity and water vapour permeability is in the same order, that is, decreases regularly as we proceed from cellulose acetate to cellulose stearate. It is interesting to know that a somewhat parallel difference is noticeable in the feel of these products and this is particularly the case with the stearate, the surface of which responds to the touch very much like wax. It would appear that as the fatty acid radicle increases in molecular weight those properties which are possessed by the corresponding acids seem to preponderate in the cellulose ester.

A similar gradation in tensile strength, elongation, hygroscopicity, and water vapour permeability is shown by other series of cellulose derivatives. Thus, it is quite marked in the ethers of cellulose such as ethyl cellulose, propyl cellulose, and butyl cellulose. Benzyl cellulose has about the same degree of hygroscopicity as cellulose stearate.

In addition to the variation of properties indicated above, that is, properties which are dependent on the nature of the acid or other radicle that is introduced into the cellulose, the variations can be introduced by other factors; thus, ethyl celluloses have been prepared which do not seem to soften at any temperature to which this cellulose derivative can be exposed. The same applies to several of the other cellulose derivatives. This variation is dependent on the amount of the radicle that is introduced into the cellulose. This effect is also noticeable on the solubility of the materials. The solubility of cellulose nitrate is closely dependent on the degree of nitration; industrial nitrocellulose of the high nitrogen class, *i.e.*, those with a nitrogen content between 11·8% and 12·3%, are readily soluble in ester solvents such as ethyl acetate and butyl acetate and also in ketones such as acetone. The medium nitrogen series with nitrogen content of 11·2% to 11·8% is completely soluble in ether–alcohol (that is a mixture of ether and alcohol), while the low nitrogen series has high solubility in weak solvent mixtures such as benzol and alcohol. In addition to the variation in properties due to the degree of chemical change which has been made in the cellulose, there is another class of changes obtainable with a cellulose derivative of a given chemical composition. These changes are related mainly to the viscosity and dependent properties. It is possible to obtain a solution of two parts of nitro-cotton (12% nitrogen) in 95% acetone which is almost a stiff jelly, while, on the other hand, the same nitro-cotton after further treatment will give an easy flowing liquid in a 40% concentration of the same acetone. Similar variations in solubility and viscosity can be obtained with some of the other esters and ethers of cellulose.

The Uses of Cellulose Derivatives in Plastics

Reference has been made earlier to the various classes of plastics made from cellulose derivatives, namely, celluloid, artificial milk, moulding powders, cellulose lacquers, and photographic films. It is not proposed here to deal with celluloid. Moreover, the technique concerned in the mannfacture and use of artificial silk is not one that is likely to be of general interest to those persons concerned with cellulose plastics. A fair idea of the general principles relating to cellulose plastics can be obtained by following out the preparation and uses of moulding powders, but a fuller view of the nature of cellulose plastics can be obtained by an examination of cellulose lacquers and the ideas involved therein relate to most cellulose plastics. The following remarks are intended to bring out the various points that are of interest in this connexion.

Cellulose lacquers

The term "cellulose" in this connexion is incomplete, for all cellulose lacquers should rather be referred to as "lacquers of cellulose derivatives." Three types of cellulose derivatives are used to some extent, namely, cellulose nitrate, cellulose acetate, and benzyl cellulose. The most important, from the point of view of quantity consumed and of general suitability of properties, is cellulose nitrate. It would be useful at this stage to make clear the sense in which the terms "lacqners" and "enamels" will be used below. By the term "lacquers" reference is made to clear compositions which are used for coating purposes. Such lacquers can be compounded in certain cases with pigments and are then referred to as "enamels" or "pigmented lacquers." The general principles underlying the preparation and use of cellulose lacquers are well illustrated in the nitrocellulose compositions.

The ingredients in an average type of enamel as it is supplied for use in coating automobiles by spraying are nitrocellulose, gum, plasticizer, spirits, toluene, ethyl acetate, butyl acetate, butyl alcohol.

The ingredients of this composition fall naturally into two classes—the volatile portion and the non-volatile portion. The latter, of course, contain the film-forming constituents.

It is usual to prepare the lacquer in four stages: (*a*) the nitrocellulose base; (*b*) the gum compound; (*c*) the pigment base; (*d*) the thinner.

The nitrocellulose, wetted with alcohol, is dissolved in the active solvents, generally ethyl acetate, amyl acetate, and butyl acetate. Usually a concentrated solution of nitrocellulose is prepared of the order of 20–30 parts nitrocellulose to 100 parts of solvent; to this is added a concentrated solution of the gum, formed by dissolving the resins in suitable solvents. It is advisable to use highly concentrated gum solution as the solvents for the resin are generally diluents for the nitrocellulose, that is, they have a tendency to precipitate the nitrocellulose from solution.

The pigment is ground in the presence of the softener and a portion of the solvents. The ball mill or pebble mill is generally used for this purpose nowadays, because it avoids loss of volatile liquid. The main drawback is the long period of grinding that is required and for this reason the triple mill is sometimes favoured. When satisfactory grinding has been obtained, the requisite weight of pigment paste is added to the solution of nitrocellulose and the whole mass is mixed thoroughly. Final adjustment of the viscosity or fluidity of the composition is made by means of the thinner. This is a liquid consisting of the chief solvents and diluents used in the above formula and is so balanced that it will not cause precipitation when added to the composition. The composition as thus prepared is generally thicker than is suitable for use. When actually spraying the lacquer or enamel it is necessary to thin the composition, and this is done most suitably by the use of a standard thinner, such as that referred to above.

For satisfactory work with most of the spraying enamels it is necessary to use air pressure of about 60 lb. per square inch and the nitrocellulose composition is thinned down to a suitable consistency which is tested by trial and error. Once the proportion of thinner to lacquer is fixed, it is seldom necessary to change this.

When finishing automobiles the bare metal is thoroughly cleaned and if there is any danger of grease or oils being present on the surface it is advisable to wipe over with benzene or toluene; the priming coat is then put on. This may be a nitrocellulose composition or an oil composition. Its purpose is to give good adhesion between the metal and the other coats, and a thin coating is generally more efficient than a thick coating. The priming coat is followed by a surfacing coat; this also may be of nitrocellulose or an oil composition. The object of this is to cover up any inequalities in the metal surface. The surfacer is rubbed down with an abrasive to give a smooth surface and is then ready for the nitrocellulose enamel. The number of coats applied depends on the quality of the finish required and varies from four to about ten coats. When the requisite number of coats have been applied, the whole surface is again rubbed down and polished. The rubbing down is necessary to remove inequalities such as an "orange peel effect" which is sometimes noticeable. When the surface has been rubbed down, it is not glossy; the gloss is obtained by polishing.

Further consideration of the composition containing the ingredients referred to in the above formula, in which the resin is, say, ester gum, and the plasticizer dibutyl phthalate, will give an idea of how to formulate a lacquer. The first important matter is to choose such a ratio of the non-volatile materials as to give a film with the required properties. Thus, if we are considering a finish for motor cars, the film must be strongly adherent to the undercoats, must be pliable, must be hard and tough, and it must be strongly resistant to outside weather.

A series of films is prepared, containing varying proportions of nitrocellulose, resin, and plasticizer and the degree of hardness, toughness, and pliability of the films tested. When a range of such results are available they are best plotted on a diagram in which nitrocellulose, resin, and plasticizer form the triangular co-ordinates. In this way it is easy to form an opinion of the compositions which will give suitable hardness, toughness, and pliability. Other properties in addition to the three above mentioned are required, the most important, as far as the finishes for outside purposes are concerned, are resistance to weather under various conditions and for prolonged periods.

Solvents

So much is known about the chemical groups which impart, to an organic substance, solvent properties for nitrocellulose that extensive additions to the list of nitrocellulose solvents can be made readily, but it is only those substances which can or will ultimately compete in price that have much chance of industrial application.

A fairly useful method of testing the solvent properties of liquids for nitrocellulose is to make up, under standard conditions, solutions of known strength and then titrate these solutions with benzene till the point is reached at which precipitation commences. In this way it will be found that solvents are divided roughly, with regard to solvent power, into the following classes: ketones, ethers of polyalcohols, and esters. It will be noted that ketones occupy the foremost place, and of these cyclohexanone has the highest solvent power. Unfortunately cyclohexanone is not quite acceptable on account of its rather unpleasant smell.

It is a well-known fact that ether alcohol, *i.e.*, a mixture of ether and alcohol, is a good solvent for certain grades of nitrocellulose. Ether alone is a non-solvent, and alcohol at ordinary temperatures only softens nitrocellulose. Yet, when suitable proportions of these are admixed together quite a good solvent is obtained. It appears that the ether group and the alcohol group in conjunction with each other act as a solvent and this effect is accomplished very well by certain organic liquids containing both groups. If one of the hydroxyl radicles of glycerin is replaced by an ether group such as the methyl or ethyl ether, quite a good solvent for nitrocellulose is obtained. Similarly, with ethylene glycol, if one of the two hydroxyl groups in this is replaced by an ether, we get a solvent for nitrocellulose: *e.g.*, cellosolve, which is the ethyl ether of ethylene

glycol, has a very high solvent power (as tested by the precipitation method), being close in value to that of cyclohexanone. There are numerous other examples of this class of solvent.

Mention has already been made of the solvent action of organic esters on nitrocellulose. Butyl acetate, for instance, is a very useful solvent for nitrocellulose in the preparation of lacquers. The solvent properties of butyl acetate can be increased by introducing a hydroxyl radicle or decreased by introducing a chlorine radicle in place of one of the hydrogens of the CH_3 radicle.

We find as we go up in the series of ethyl acetate homologues that the solvent power decreases. It is interesting to note that certain mixtures of solvents and so-called partial solvents, such as the alcohols, are more effective when a diluent is present.

Gelatinizers

From scientific and commercial aspects the plasticizing of cellulose derivatives is of considerable importance; this applies equally to their use in lacquers, films, and moulding powders. The term "plasticizer" is one that is not easy to define. We are familiar with the meaning of the word "solvent": for instance, it is clear what is meant by saying that acetone is a solvent for nitrocellulose. Although it is customary to refer to tricresyl phosphate and castor oil as plasticizers of nitrocellulose the action of each is different.

Tricresyl phosphate is able to transform a certain grade of nitrocellulose (HX 45—140 or ½-sec.—1 sec.) into a transparent gel at ordinary temperatures, while castor oil has no visible effect on this grade of nitrocellulose. This difference has been used to classify plasticizers as gelatinizers and softeners, the former referring to those substances which, like tricresyl phosphate, convert the cellulose derivative into a gel, and the latter to substances, such as castor oil, which possess plasticizing properties, although they have no visible effect on the cellulose derivatives. The difference is similar to that between solvents and certain diluents. If sufficient gelatinizer is added to a cellulose derivative a jelly is obtained; sometimes heat has to be applied to bring about solution. This jelly or gel can be further dispersed to give a homogeneous composition by adding it to more of the gelatinizer. No matter how much softener is added to a cellulose derivative no change seems to take place in the cellulose material, whatever the temperature. Just as solubility alters with the temperature, so also does the action of a gelatinizer.

One of the most important features of a plasticizer should be its permanence, and in this respect it is essentially different from a solvent. A plasticizer is required to remain in the material to which it is added, while a solvent is used generally to aid the application of the cellulose derivative, and is applied under such conditions that it can be removed completely; *e.g.*, certain lacquers, to which forced drying is applied, contain highly volatile solvents such as acetone, ethyl alcohol; other lacquers which dry at ordinary temperatures contain solvents boiling around 120° C. Plasticizers as a rule possess very low volatility, and seldom are any materials classed as plasticizers which have a boiling point below 250° C. Camphor, which boils at around 209° C., is an exception to this. Typical plasticizers for nitrocellulose, such as tricresyl phosphate, boil at about 300° C.

Reference has been made above to single solvents which possess solvent properties similar to mixtures of liquids in their effect on nitrocellulose. The same idea can be utilized in the search for gelatinizers for cellulose derivatives. In much the same way as a mixture of ether and alcohol is a solvent for nitrocellulose and ethyl ether of ethylene glycol is a single solvent for nitrocellulose, so are the dibutyl and diamyl ethers of glycerol gelatinizers for nitrocellulose.

Artificial leathercloth

Another direction in which cellulose derivatives are used in considerable quantities is for the manufacture of artificial leathercloth. The process of manufacture consists essentially in applying a suitably coloured plastic mass of cellulose derivative to a woven (generally cotton) fabric and thereafter impressing the required grain in relief upon the product by means of embossing plates or rolls. Most of the artificial leathercloth in use at present is made from nitrocellulose, although a limited amount is prepared from some of the other cellulose derivatives.

Moulding powders

Another use of cellulose derivatives to which considerable attention has been paid recently is for the preparation of moulding powders. Nitrocellulose is not used to any marked extent in this direction, but the development of the use of cellulose acetate and of benzyl cellulose has been considerable. These moulding powders consist of a cellulose derivative and gelatinizer, suitably shaded and modified by the addition of pigments and fillers. The moulding may be carried out either by compression moulding or injection moulding. The usual class of moulding powders made from benzyl cellulose for injection work are suitable for temperatures ranging between 130° and 170° C.

It is not usual to associate explosives with the plastics industry, yet the technique involved in the manufacture of cordite comes very close to that required for cellulose plastics. The matter is mentioned here to emphasize the availability in this country of considerable knowledge of the principles which are involved in the manufacture and in the use of thermoplastic cellulose derivatives.

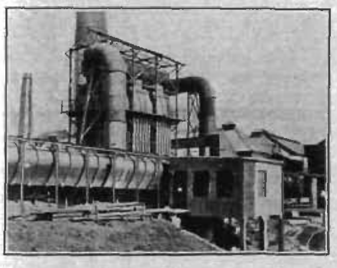
ELECTROSTATIC DUST SEPARATION

In the chemical and allied industries the electrostatic method of separating solid or liquid particles from gases is now in extensive commercial use. Some well-known applications are in the manufacture of sulphuric acid, both for the removal of dusts from hot burner gases and the elimination of mists in the contact process and also in the concentration plant, the recovery of valuable dusts of all kinds in connexion with the smelting or roasting of tin, copper, lead, arsenic, and other ores, the "de-tarring" of carbonization gases, and the cleaning of blast-furnace gas.

A huge new field now developing is the separation of dust particles from combustion gases, especially power

stations operating with pulverized fuel firing. The progress made is emphasized by the recent report of the committee appointed by the Electricity Commissioners to study the question of "The Emission of Soot, Ash, Grit, and Gritty Particles from the Chimneys of Electric Power Stations" (H.M. Stationery Office, 1932, 5s. net). The report states "with pulverized fuel fired installations some form of dust extraction plant is necessary and the most suitable type is the electrostatic precipitator," superior therefore to water-washing or cyclone methods.

In power station practice the removal of the dust from the combustion gases is a formidable undertaking because of the huge volumes involved, averaging 500,000—600,000 cb. ft. of gases at say 275—300° F. (135—150° C.) per ton of coal burnt. Also in the case of pulverized fuel firing 50%—70% of the ash of the coal may be in the form of dust in the gases, and often 75% of the dust particles are less than 10 microns in size and therefore very difficult to remove. The basic principle



TYPICAL "LODGE-COTTRELL" ELECTROSTATIC SEPARATION PLANT OF THE "PIPE" TYPE FOR THE TREATMENT OF SMELTED FUMES

f using an electrostatic field by means of discharge lectrodes, operating with high tension direct current t 60,000—70,000 volts, so as to electrify, and therefore epel, the particles to collector electrodes, has a number f advantages. These include dry separation, practically qual separation efficiency irrespective of the size of the articles, no mechanical obstruction to the passage of he gases, and no reduction in temperature and therefore himney draught. Also with an efficient design of plant he total power used is reasonable in amount, 1½ to kw.-hr. per 1,000,000 cb. ft. of gas, and the cost of aintenance is low.

In this connexion it will be interesting to give a brief ésumé of the main history of the process. Although he action of electricity on dust and liquid particles uspended in a gas seems to have been first observed more han a century ago the practical pioneer is Sir Oliver odge. Thus he started work on the subject in 1883, ith J. W. Clark, and in 1884 he demonstrated in triking fashion at the British Association Meeting in Montreal the effect of electric discharge on the precipitation of solid and liquid particles from a gaseous medium, especially water particles from steam. For detailed information on this early work reference is recommended to "Electrical Precipitation" by Sir Oliver Lodge (Oxford University Press, 1925). His two sons followed up the matter, and as a result the process became a commercial proposition with the formation of the Lodge Fume Deposit Company. Electrostatic precipitation was also afterwards developed independently by Dr. F. G. Cottrell in the United States and Dr. Erwin Möller in Germany. Eventually an agreement resulted between the British and American interests that led to the formation of Lodge-Cottrell, Ltd. Finally in 1930 a close working arrangement was made between the respective companies throughout the world, specializing on electrostatic precipitation, with free interchange of all experience and improvements. These companies comprise Lodge-Cottrell, Ltd. (for the British Empire), Western Precipitation Co., Los Angeles, and the Research Corporation, New York (for the American Continent), and the Lurgi Apparatebau G., Frankfurt, and Siemens-Schuckertwerke A.-G., Berlin (for Germany and the Continent of Europe), while companies in other countries such as Japan, for example, have licences. The result has been notable improvements in the process especially as regards reduction in capital cost, and already over 1000 electrofilters have now been installed in connexion with the chemical industry in the major countries of the world.

SIXTY-NINTH ANNUAL REPORT ON ALKALI ETC. WORKS, 1932*

The number of works registered in 1932 was 921 and of processes under inspection 1720. These figures are respectively 63 and 73 less than those of 1931, tar and sulphate of ammonia processes showing considerable decreases, but benzene works an increase. Details of numbers of plants registered under the different headings are given, a new feature in this year's report. Amongst sundry complaints referred to are (1) green gas from coke ovens; new installations have special devices to avoid this; (2) smells from oil-fired domestic furnaces in which good control is necessary; (3) the exhaust gases from viscose works. Experimental treatment by chlorination has shown that only one-eighth of the theoretically required chlorine is necessary to destroy the odour which is not due to hydrogen sulphide, but to an organic S compound. A fatal accident during the removal of sludge from a sulphuric acid tank wagon led to investigations which established that hydrogen sulphide is frequently present in dangerous concentrations in such tanks. The danger limit for this gas is 0·15%—0·26%; it is more dangerous than carbon monoxide and the sense of smell cannot be relied upon in detecting it. Such tanks should always be washed out with water before entering.

Alkali and copper (wet process) works.—The tonnage of salt decomposed in 1932 was: Salt cake process, 53,648 tons; wet copper process, 7039 tons. The latter is now regularly operated at only one works.

Cement works.—Output continues restricted; spray feeding has now been entirely abandoned. An

* By the Chief Inspectors, pp. 46. H.M. Stationery Office. Price 9d.

improvement has occurred in the arrest of dust from bagging and grinding plants.

Smelting works.—The average of all tests on exit gases showed an acidity of 2·62 grains (as sulphur trioxide) per cubic foot. No efficient means has yet been devised for the trapping of zinc fumes. Lead fumes are treated by either a Lodge-Cottrell precipitator or by dust chambers followed by cyclones. There has been a slight increase in activity in tin-mining.

Sulphuric acid works.—A substantial increase in output over that of 1931 is recorded. Even so, only 60% of plant capacity is in use.

Sulphuric acid (Class II) works.—In the Billingham plant, where oleum is made by the contact process from anhydrite, the converter exit gases are washed with a solution of ammonium sulphate and ammonia in a tower packed with rings. The resultant sulphite liquor is decomposed with sulphuric acid and the sulphur dioxide returned to process. Entrainment of spray is avoided by the use of a second (dry) tower.

Chemical manure works.—There has been some improvement in the superphosphate industry in the South of England. Several Broadfield continuous dens have been in talled.

Sulphate and muriate of ammonia and gas liquor works.—There has been a further decline in the number of sulphate plants registered, and many are only working intermittently. Leakages of hydrogen sulphide cannot be tolerated, and in one case in which a fatality occurred legal proceedings were taken. The concentration of gas liquor for transport to central works for further treatment is advocated.

Chlorine works.—A very large Bachmann plant for the continuous production of bleaching powder has been erected at Staveley and is up to the present entirely succes ful.

Sulphide works.—An explosion occurred in a works where rubber is vulcanized by successive treatment with sulphur dioxide and hydrogen sulphide. Ignition appears to have been due to iron sulphide on the chamber walls becoming incandescent and causing an explosion of sulphur dust. A similar explanation is offered for an explosion in the Claus kiln of a carbon bisulphide plant.

Paraffin oil works.—Serious difficulties are described in dealing with the noxious gases evolved at an oil refinery. The gas, chiefly butane and olefines, is admixed with sulphur compounds and small leakages are noticeable at considerable distances.

Tar works.—Greater care is needed in the treatment of tail gases. In one works the washing of these has led to an appreciable recovery of oil. Two gasworks have used the sensible heat of their crude gas to effect the dehydration of tar.

Benzene works.—Uncondensed gases should be treated by one of the following methods: (1) where scrubbing is prior to oxide purification, the foul gas can be taken through a seal to the suction side of the exhauster; (2) if after oxide purification the foul gas can be returned to the washer under pressure through a seal; (3) a special small scrubber fed with debenzolized oil may be provided. Vents from storage tanks should be coupled to the uncondensed gas main.

SOCIETY OF CHEMICAL INDUSTRY

OFFICIAL NOTICES

Members are reminded that new members introduced at the present time may, if they prefer, pay a half-yearly subscription of £1 7s. 6d. terminating on December 31 next. Such members receive the JOURNAL only from July 1 of this year and are understood to have the inteution of continuing their membership in 1934.

Associate Members. A new form of associate membership is now in force at a yearly subscription of 7s. 6d. A copy of the Annual Reports on the Progress of Applied Chemistry is supplied instead of the JOURNAL but in many respects the benefits of full membership are provided. The age limit is 23. Full particulars may be obtained on application to the General Secretary, 46, Finsbury Square, London, E.C.2. Members are particularly requested to encourage their young friends to graduate into full membership by this means.

Back Numbers. Copies of the earlier numbers of the JOURNAL back to the earliest years with a few exceptions may be secured on application to the General Secretary. The cost from 1923 onwards is 1s. 10d. per copy, post free, and in all cases the appropriate remittance must accompany the order. It will save delay if this rule be observed.

PERSONAL AND OTHER ITEMS

Dr. A. E. Dunstan is to lecture at the annual meeting of the American Chemical Society in Chicago, on September 13, on "Recent Developments in the Pyrolysis of Gaseous Hydrocarbons," and at the annual meeting of the American Petroleum Institute in Chicago, on October 21, on "Twenty Years of Petroleum Research—A Retrospect."

We regret to announce the death of Sir Philip Magnus, Bt., physicist and educationist, on August 29. An obituary notice will appear in a later issue.

We regret to announce the death of Sir Malcolm Robinson, formerly Chief Inspector of Factories; he died on August 27 at Parkstone, Dorset, at the age of 76.

The Institute of Fuel

A paper on "The Progressive Action of Hydrogen on Coal" is to be presented to members of the Institute of Fuel on November 8 by Drs. J. G. King, L. Horton, and F. A. Williams. The meeting will be held in the rooms of the Chemical Society, Burlington House, and the Institute has issued a cordial invitation to members of the Society to attend and take part in the discussion. Members of the Society will also be welcomed at the meeting of the Institute on October 11 at 8.30 p.m. in the lecture theatre of the Geological Society, London when Sir John Cadman, Melchett medallist for 1933 will deliver the medal address, and at the meeting on October 18, at 11.30 a.m., also in the Geological Society's rooms, when the president-elect of the Institute, Sir William Larke, K.B.E., will give his presidential address. At 2.30 in the afternoon of the same day, Dr. Ing. Koppers is to present a paper on "Recent Developments in Coking Practice," and members of the Society are also invited to attend this meeting.

Office International de Chimie

In 1932 the Office International de Chimie was formed by international convention with the object of studying questions relating to international documentation with special reference to chemistry. Many famous scientists from the Continent attended a conference summoned by the Office International de Chimie, amongst whom was Prof. J. C. Philip. As a result of this conference a summary of the objects which the office intends to pursue has recently been made public. They are: (1) To render accessible to all interested persons the already existing documentation, accumulated in the various centres, depôts, and collections; (2) to guide the chemical documentation which is in course of production, in such a way as to facilitate its registering, filing, and diffusion by methods found to be the best; (3) to ensure co-ordination between the documentation relative to chemistry and that concerning other scientific knowledge in the field of international documentation.

The address of the office is 49, Rue des Mathurins, and it is under the direction of M. Jean Gérard.

Borates

The uses of borax and boric acid have been considerably extended in recent years owing to reductions in price and to research work carried out by the larger producing companies. The present extent of these uses is well shown in *Borates* (H.M.S.O., 9d., 44 p.) which is an addition to the series of monographs compiled by the Imperial Institute on the mineral resources of the British Empire.

Borax finds employment in the manufacture of glass, pottery, adhesives, and paper; also in leather dressing, dyeing, enamelling, and metallurgy. Its many domestic uses include that of a water softener and cleanser, and its derivative sodium perborate is an important bleaching agent. Manganese borate is used in the manufacture of paint, printing inks, and linoleum. The mild antiseptic and detergent properties of boric acid and borax render them of value in pharmacy.

The monograph describes the occurrence of borax minerals in America, Turkey, Italy and other parts of the world, and gives concise descriptions of the methods of production which are employed.

The Imperial Institute

The Imperial Institute Annual Report for 1932 (2s.) gives an epitome of the Institute's activities in its three branches, intelligence, laboratory investigation, and education. In each department the work has continued to increase, and since 1926 there has been an increase of 20% in the number of samples investigated and of 30% in the inquiries dealt with. These figures alone give an indication of the appreciation of the Institute's work, but this appreciation is easily understood when one reads of the many varied investigations carried out by the committees on silk, timber, vegetable fibres, oilseeds, resins, tanning materials, hides and skins, and of the many samples examined and the extent of the advice given by the advisory council and technical committees of the Mineral Resources Department. The report contains a complete list of the personnel engaged in this work, which has been of considerable value to the Empire.

Canadian Mining

It is reported that the production of gold by Canadian mines this year is not likely to show much advance over the figures for 1932, though in dollar value it will show a very substantial gain, estimated at approximately \$85,000,000 as against \$71,000,000 in 1932.

The Dominion Bureau of Statistics at Ottawa has just issued a bulletin containing a considerable amount of information relative to the smelting and refining of domestic and imported ores in Canada last year, together with a summary of world statistical data. From this report it appears that 10 Canadian companies operated 13 metallurgical plants last year, having a total capitalization of \$149,708,860, and employing 5343 persons. The value of smelter products turned out was \$76,442,076. Data are also given in the report relative to the operations of the principal smelting and refining plants.

New Fellowship at the Mellon Institute

The Buromin Co. of Pittsburgh has founded an industrial fellowship at Mellon Institute, Pittsburgh, for the purpose of investigating the properties of dehydrated phosphates of the alkali metals in water conditioning and washing, and to extend the uses of these chemicals. Dr. Bernard H. Gilmore has been appointed to the fellowship.

World Production of Copper Sulphate

Statistics published recently in *Die Chemische Industrie* show a small increase in both the production and use of copper sulphate in 1932 compared with 1931. Production in 1932 amounted to 285,501 tons, Italy contributing 99,567 t., France 44,000 t., Great Britain 48,285 t., Germany 30,000 t., Belgium 24,449 t., and the U.S.A. 22,700 t. Production in Italy and in this country showed a marked increase compared with 1931, when the figures were 77,271 t. and 33,860 t. respectively. French production showed a decline (52,200 t., 1931). By far the largest users in 1932 were Italy (105,700 t.) and France (82,800 t.).

Exposition of Chemical Industries

A programme of student courses in chemical engineering, industrial chemistry, and the economics of the chemical industry are to be given during the holding of the fourteenth Exposition of Chemical Industries at Chicago in December this year. Prof. W. T. Read, dean of the school of chemistry of Rutgers University, will be in charge of the courses, and will be assisted by a group of well-known American chemists and chemical engineers. At the last Exposition more than 2000 students attended similar courses.

Research in Australia

The Sixth Annual Report of the Commonwealth of Australia Council for Scientific and Industrial Research for the year ended June 30, 1932, is an account of a large amount of useful work, much of which has an immediate practical significance. Much of this work has been concerned with plant and animal diseases, which cause very heavy losses each year. In the Forest Products Division an important feature of the year's work has been the success which has attended the investigations on the prevention of wood taint in butter. The method of spraying with a solution

of casein and formalin has been developed and tested out in a practical way. The results have been satisfactory and as soon as the complete results of experimental shipments are available steps will be taken for the application of the process on a commercial scale. The successful development of the process will be of very considerable advantage to the dairy and timber industries. The study of the chemistry of Australian timbers is being pursued and this work is likely to be of considerable importance as chemical methods of utilizing wood are extended in Australia. The manufacture of paper, artificial silk, lacquers, etc. must eventually be established here and the data now being collected will then prove of the greatest value. It is interesting to note the growth of kiln seasoning during the few years of the Division's activities. There are now in Australia 58 kiln installations with a total of 138 kilns.

Considerable work is also being done in connexion with problems of cold storage and transport of meat and fruit. Soil survey work and mineragraphic investigations are also making headway. The report contains details of the publications of the Council during the year, and gives a list of all the principal officials engaged on scientific work.

COMPANY NEWS

CALICO PRINTERS' ASSOCIATION

The net profit of the Association for the year ended June 30 last was £123,926, after providing £366,790 (against £359,970) for maintenance, depreciation, repairs, renewals, and upkeep, and £128,000 for debenture interest; this represents a decrease of £33,532 compared with the net profit for the previous year. With £10,475 brought in there is a total credit balance of £134,401. A transfer of £50,000 is to be made from general reserve to the credit of the profit and loss, and a dividend has been recommended on the preference shares for the half-year ended June 30 at the rate of 5% per annum, making the full 5% for the year. The balance of £33,596 is to be carried forward.

YORKSHIRE DYEING AND PROOFING CO., LTD.

The directors of the company have announced a dividend of 6%, less tax, on the ordinary shares. This is the first dividend of the company since it was converted into a public company in November, 1932. The company was formed as a private concern in 1920 and at the conversion in November last 350,000 ordinary shares of 10s. each were offered to the public at 12s. per share. The total authorised and share capital, issued and paid up, is £190,000.

E. I. DU PONT DE NEMOURS & CO.

The company reports net earnings for the first half of 1933 of $11,277,550, or $1·03 per share, as compared with $10,962,167 and $1·01 per share for the same period in 1932. Net income from operations, after provision for depreciation and obsolescence amounts to $8,421,065, as compared with $4,861,939 last year. Income from investments realized $7,418,186, making a net income, after provision for taxes etc., of $14,455,258, which is slightly higher than the amount for the same six months last year. The consolidated balance-sheet shows floating assets at June 30 of $125,401,106, as against current liabilities of $11,474,984.

MARKET REPORT

This Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acid, Acetic, 40% tech.—£20 5s. per ton d/d address U.K. in casks.

Acid, Chromic.—10½d. per lb., less 2½% d/d U.K.

Acid, Hydrochloric.—Spot, 4s.—6s. per carboy d/d according to purity, strength, and locality.

Acid, Nitric 80° Tw.—Spot, £18—£25 per ton makers' works, according to district and quality.

Acid, Sulphuric.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 60s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.

Ammonia (Anhydrous).—Spot, 10d. per lb. d/d in cylinders.

Ammonium Bichromate.—8d. per lb., d/d U.K.

Bisulphite of Lime.—£6 10s. per ton. f.o.r. London, packages free.

Bleaching Powder, 35/37%.—Spot, £8 15s. per ton d/d station in casks, special terms for contracts.

Borax, Commercial.—Granulated, £15 10s. per ton; Powder, £17 per ton. (For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.)

Calcium Chloride, Solid, 70/75%.—Spot, £5 5s. per ton d/d station in drums.

Chrometan.—Crystals, 3¼d. per lb.; Liquor, £19 10s. per ton d/d U.K.

Chromium Oxide.—10½d. per lb., according to quantity, d/d U.K.

Methylated Spirits, 61 O.P.—Industrial, 1s. 8d.—2s. 3d. per gal.; Pyridinized Industrial, 1s. 10d.—2s. 5d. per gal.; Mineralized, 2s. 9d.—3s. 3d. per gal. 64 O.P. 1d. extra in all cases. Prices according to quantity

Nickel Sulphate.—£49 per ton d/d.

Nickel Ammon. Sulphate.—£49 per ton d/d.

Potash, Caustic.—£30—£33 per ton. Potass. Bichromate crystals and granular.—5d. per lb., net d/d U.K., for spot. Discount according to quantity. Ground, 5¾d. per lb.

Potassium Chromate.—6½d. per lb., d/d U.K.

Sal ammoniac, Firsts lump.—Spot, £42 17s. 6d. per ton d/d address in barrels. Chloride of Ammonia.—£37—£45 per ton, carr. paid.

Salt Cake, unground.—Spot, £3 15s. per ton d/d station in bulk.

Soda Ash, 58° E.—Spot, £5 17s. 6d. per ton, f.o.r. in bags, special terms for contracts.

Soda, Caustic, solid 76/77° E.—Spot, £14 5s. per ton d/d station in drums, special terms for contracts.

Soda crystals.—Spot, £5—£5 5s. per ton d/d station or ex depôt in 2-cwt. bags.

Sod. Acetate 97/98%.—£21 per ton. Sod. Bicarbonate (refined).—Spot, £10 10s. per ton d/d station in bags. Sod. Bichromate Crystals, Cake, and Powder—4d. per lb., net d/d U.K., discount according to quantity. Anhydrous 5d. per lb. Sod. Bisulphite Powder 60/62%.—£16 10s. per ton delivered, 1-cwt iron drums for home trade.

Sodium Chromate.—3⅞d. per lb., d/d U.K.

S. Phosphate.—£12 10s. per ton, f.o.r. London, casks free. Sod. Silicate 140° Tw.—Spot, £8 5s. per ton d/d station, returnable drums. Sod. Sulphate (Glauber's Salt).—Spot, £4 2s. 6d. per ton d/d. Sod. Sulphide solid, 60/62%.—Spot, £10 15s. per ton, d/d in drums. Crystals, 30/32%.—Spot, £8 per ton, d/d in casks. Sod. Sulphite, Pea Cryst.—Spot, £13 10s. per ton, d/d station in kegs; Commercial.—Spot, £9 10s. per ton, d/d station in bags.

RUBBER CHEMICALS

Antimony Sulphide.—Golden.—6½d.—1s. 1¼d. per lb., according to quality. Crimson.—1s. 3d.—1s. 5d. per lb., according to quality.

Arsenic Sulphide, Yellow.—1s. 5d.—1s. 7d. per lb.

Barytes.—£7 10s.—£9 per ton, according to quality.

Cadmium Sulphide.—2s. 9d.—3s. 1d. per lb.

Carbon Bisulphide.—£30—£32 per ton, according to quantity, drums extra.

Carbon Black.—3¾d.—4⅞d. per lb., ex wharf.

Carbon Tetrachloride.—£41—£46 per ton, according to quantity, drums extra.

Chromium Oxide, Green.—1s. 2d. per lb.

Diphenylguanidine.—2s. 2d. per lb.

India-rubber Substitutes, White.—4¼d.—4⅞d. per lb. Dark.—3½d.—4¼d. per lb.

Lamp Black.—£45—£48 per ton.

Lead Hyposulphite.—9d. per lb.

Lithopone, 30%.—£17 10s.—£18 per ton.

Mineral Rubber "Rupron."—£18 10s. per ton.

Piperidine Rubber Accelerators.—P.P.D.—10s. 6d.—11s. 6d. per lb.; Z.P.D.—7s.—7s. 6d. per lb.; L.P.D.—6s. 6d.—7s. per lb.; P.T.D.—9s. 6d.—10s. 4d. per lb.; C.P.D.—8s. 3d.—8s. 10d. per lb.; S.P.D.—8s. 1d.—8s. 7d. per lb.; P.T.M.—11s. 6d.—12s. 6d. per lb.

Sulphur.—£11 10s. per ton. *Sulphur Precip. B.P.—£55—£60 per ton. Sulphur Precip. Comm.—£50—* £55 per ton.

Sulphur Chloride.—5d.—7d. per lb., according to quantity.

Vermilion, pale or deep.—4s. 3d.—4s. 5d. per lb.

Zinc Sulphide.—11d.—1s. per lb., according to quality

WOOD DISTILLATION PRODUCTS

Acetate of Lime.—Brown, £8 15s.—£9 per ton. Grey, £14—£16 per ton. Liquor, Brown, 30° Tw., 6d. per gal.

Amyl Acetate, technical.—95s.—110s. per cwt.

Charcoal.—£6—£11 per ton, according to grade and *locality*.

Methyl Acetone, 40/50%.—£50—£52 per ton.

Wood Naphtha.—Miscible, 3s.—4s. per gal. Solvent, 3s. 9d.—4s. 9d. per gal.

Wood Tar.—£2 10s.—£6 per ton.

Wood Creosote.—6d.—2s. per gal.

TAR PRODUCTS

Acid Carbolic.—*Crystals.—9d.—10d. per lb.* Crude 60's, 2s. 5d.—2s. 6d. per gal. 2% water—3s. 0¾d. per gal.

Acid Cresylic, 99/100.—1s. 6d.—1s. 8d. per gal., *according to specification. Refined, 1s. 8d.—1s. 9d. per* gal. Pale, 98%, 1s. 4d.—1s. 5d. per gal. 95%, 11d.—11½d. per gal. Dark, 10d. per gal.

Anthracene Oil, Strained, 4½d. per gal.

Benzole.—Prices at works: Crude, 9d.—9½d. per gal.; Standard motor, 1s. 4d.—1s. 4½d. per gal.; 90%, 1s. 5d.—1s. 6d. per gal.; Pure, 1s. 7½d.—1s. 8d. per gal.

Creosote.—B.S.I. specification, 3d. per gal., d/d. Heavy—4d. per gal.

Naphtha.—Solvent, 90/160, 1s. 4d.—1s. 5d. per gal. Solvent, 95/160, 1s. 8d. per gal. Solvent 90/190, 11d.—1s. per gal.

Naphthalene.—Purified crystals, £9 10s. per ton in bags. Crude, Hot Pressed, £6 5s. per ton. Flaked,

Pitch, medium, soft.—80s. per ton, in bulk at makers' works.

Pyridine.—90/140—4s. 3d. per gal.; 90/180—2s.—2s. 3d. per gal.

Toluole.—90%, 2s. 4d. per gal. Pure, 2s. 8d. per gal.

Xylol.—2s. 2d.—2s. 3d. per gal. Pure, 2s. 4d.

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Acid, Acetic, Pure 80%.—£39 5s. per ton d/d address U.K. in casks.

Acid, Acetyl Salicylic.—2s. 9d.—2s. 11d. per lb., according to quantity.

Acid, Benzoic, B.P.—1s. 9d.—1s. 11d. per lb. Solely ex Gum.—1s. 3d.—1s. 6d. per oz.; 50-oz. lots, 1s. 3d. per oz.

Acid, Boric, B.P.—Cryst., £35 10s. per ton. Powder, £36 10s. per ton. Ex-Fine Powder, £38 10s. per ton. For 1-ton lots and upwards, packed in 1-cwt. bags, carriage paid any station in Great Britain.

Acid, Camphoric.—19s.—21s. per lb.

Acid, Citric.—9½d. per lb. Less 5%.

Acid, Gallic.—2s. 9d. per lb. for pure crystal in 1-cwt. lots.

Acid, Molybdic.—5s. 3d.—5s. 9d. per lb., according to quantity.

Acid, Pyrogallic. Cryst.—6s. 9d. per lb. for 1-cwt. lots. Resublimed.—8s. 6d. per lb. for 28-lb. lots d/d.

Acid, Salicylic.—B.P. pulv., 1s. 7d.—1s. 10d. per lb. Technical, 1s. 2d.—1s. 4d. per lb.

Acid, Tannic, B.P.—3s. 9d. per lb.

Acid, Tartaric.—11¾d. per lb. Less 5%.

Acetanilide.—1s. 5d. per lb.

Ammon. Benzoate.—3s. 3d.—3s. 9d. per lb.

Ammonium Hippurate.—19s. 6d.—23s. 6d. per lb.

Ammonium Iodide.—17s.—17s. 6d. per lb.

Ammonium Molybdate.—5s.—5s. 6d. per lb., according to quantity.

Argent. Nitras, Crystal.—1s. 1d. per oz.

Arsenic Iodide.—22s. 6d.—25s. per lb.

Benzonaphthol.—3s. 3d.—3s. 9d. per lb.

Berberine, Hydrochloride.—5s. 6d.—6s. per oz.; Sulphate, 5s. 6d.—6s. per oz.

Bismuth Salts.—Carbonate, 6s. 10d. per lb.; Citrate, 9s. 3d. per lb.; Nitrate (cryst.), 4s. 7d. per lb.; Oxide, 10s. 6d. per lb.; Salicylate, 7s. 7d. per lb.; Subchloride, 10s. 3d. per lb.; Subgallate, 7s. 3d. per lb.; Subnitrate, 5s. 11d. per lb. Above for cwt. lots. Extra and reduced prices for smaller and larger quantities respectively. Liquor Bismuthi, P.B., in W. Qts.—1s. 1½d. per lb.; 6 W. Qts.—11d. per lb.; 12 W. Qts.—9½d. per lb.; 36 W. Qts.—9d. per lb.

Borax, B.P.—Crystal, £24 10s. per ton. Powder, £25 *per ton.* For 1-ton lots and upwards, packed in 1-cwt. bags, carr. paid any station in Great Britain.

Bromides, B.P.—Ammonium.—1s. 10d. per lb. Potassium.—1s. 7d. per lb. *Sodium.*—1s. 9d. per lb. Prices for 1-cwt. lots.

Cadminm Iodide.—14s. 6d. per lb.

Calcium Hippurate.—26s.—30s. per lb.

Calcium Iodide.—20s. per lb.

Calcium Lactate, B.P.—1s. 2d.—1s. 4d. per lb., according to quantity.

Camphor.—Refined flowers, 3s. 1d.—3s. 2d. per lb. Transparent tablets, 3s. 4d.—3s. 6d. per lb., according to quantity; also special contract prices.

Chloroform.—2s. 3d.—2s. 8d. per lb.

Cinchophen.—11s. 6d.—12s. 6d. per lb.

Cocaine, Alkaloid and Citrate.—For export.—29s. 10d.—31s. 7d. per oz. Hydrochloride and Nitrate, 27s. 1d.—28s. 11d. per oz.

Ephedrine hydrochloride.—5s. 6d.—6s. per oz.

Ergosterol.—2s. 6d. per gm.

Ethers.—S.G. 730, 1s. 1d.—1s. 2d. per lb., according to quantity, and other prices according to specific gravity.

Hexamine.—2s. 4d.—2s. 6d. per lb., according to quantity.

Hippuric Acid.—17s. 6d.—21s. 6d. per lb.

Hydrogen Peroxide (12 vols.).—1s. 4d. per gal., f.o.r. makers' works, naked. B.P.—10 vols., 2s.—2s. 3d. per gal.; 20 vols., 3s. per gal.

Hypophosphites.—Calcium, 2s. 9d.—3s. 2d. per lb. Potassium.—3s. 4d.—3s. 9d. per lb. Sodium, 2s. 11d.—3s. 4d. per lb.

Iodine Resub., B.P.—14s. 8d.—18s. 9d. per lb.

Iodoform, B.P., Cryst., Precip. or Powder.—17s. 7d.—21s. 7d. per lb.

Iron Ammon. Citrate.—B.P.—1s. 9d. per lb. for 28-lb. lots. Green, 2s. 5d. per lb. (list price).

Iron Iodide.—17s. 6d.—18s. per lb.

Iron Perchloride.—18s.—20s. per cwt., according to quantity.

Iron Quinine Citrate, B.P.—9¾d.—1s. 0½d. per oz., according to quantity.

Lead Iodide.—14s.—15s. per lb.

Lithium Carbonate, B.P., 1914.—5s. 4d. per lb.

Lithium Chloride, Cryst.—8s. 3d. per lb.

Lithium Citrate.—5s. 3d. per lb. Powder.—5s. 6d. per lb.

Lithium Hippurate.—18s. 6d.—22s. 6d. per lb.

Lithium Iodide.—20s. 6d.—21s. 6d. per lb.

Magnesium Carbonate.—Light, 28s. per cwt.

Magnesium Oxide.—Light, 70s. per cwt.; Heavy, 1s. 8d. per lb.; in quantity lower.

Menthol.—A.B.R., recryst., B.P., 15s. per lb. net. Synthetic, 8s. 6d.—12s. per lb. Synthetic detached crystals, 8s. 6d.—10s. 6d. per lb., according to quantity; Liquid (95%), 8s. 6d. per lb.

Mercurials, B.P.—Red oxide crystals, 5s. 10d.—5s. 11d. per lb.; Levig, 5s. 4d.—5s. 5d. per lb.; Corrosive sublimate, Lump, 4s.—4s. 1d. per lb.; Powder, 3s. 8d.—3s. 9d. per lb.; White precip., Lump, 4s. 9d.—4s. 10d. per lb.; Powder, 4s. 11d.—5s. per lb.; Calomel, 4s. 9d.—4s. 10d. per lb. Yellow Oxide, 5s. 2d.—5s. 3d. per lb.; Persulph., B.P.C., 4s. 11d.—5s. per lb.; Sulph. nig., 4s. 10d.—4s. 11d. per lb. Special prices for larger quantities.

Mercury, Benzoate.—8s. 3d. per lb.; Cyanide, 12s. 7d.—13s. 1d. per lb.; Oleate (5%), 1s. 11d.—2s. 2d. per lb.; (10%), 2s. 9d.—3s. per lb.; (20%), 3s. 9d.—4s. per lb. Protonitras, 6s. 9d. per lb.; Protosulphate, 7s. 3d. per lb.; Subsulphate flav., 7s. 1d. per lb.

Methyl Salicylate.—1s. 4½d.—1s. 6½d. per lb.

Paraformaldehyde.—1s. 3d.—1s. 5d. per lb.

Paraldehyde.—1s. 4d.—1s. 10d. per lb.

Phenacetin.—4s.—4s. 6d. per lb.

Phenolphthalein.—4s. 5d.—5s. 8d. per lb.

Potass. Bitartrate.—99/100% (Cream of Tartar), 80s. per cwt., less 2½%.

Potass. Citrate.—B.P., 1s. 7d. per lb. for 28-lb. lots.

Potass. Ferricyanide.—1s. 7½d. per lb., in 125-lb. kegs.

Potass. Iodide, B.P.—13s.—15s. 6d. per lb., according to quantity.

Potass. Permanganate.—8¼d. per lb. for 1-ton lots.

Potass. Metabisulphite.—50s. per cwt. d/d London, kegs free.

Potassium Hippurate.—26s.—30s. per lb.

Quinine Sulphate.—1s. 10d. per oz., for 100-oz. tins, tins free.

Saccharin.—37s. 6d. per lb., and lower in quantity.

Salicin.—15s.—16s. per lb., according to quantity.

Santonin, B.P.—28s. per oz.

Seidlitz powder (pulv.).—55s.—58s. 9d. per cwt.

Silver Nitrate.—1s. 3¼d. per oz. for quantity. Sticks, 2d. per oz. extra.

Sod. Barbitonum.—13s. 9d.—15s. per lb.

Sod. Benzoate, B.P.—1s. 7d. per lb., according to quantity.

Sod. Citrate, B.P.C., 1911.—1s. 4d. per lb. B.P.C., 1932, and U.S.P.—1s. 8d. per lb. for 28-lb. lots.

Sodium Hippurate.—23s. 6d.—27s. 6d. per lb.

Sod. Hyposulphite.—Photographic, £15 per ton d/d consignee's station, in 1-cwt. kegs.

Sodium Iodide, B.P.—14s.—17s. 1d. per lb.

Sod. Nitroprusside.—16s. per lb.

Sod. Potass. Tartrate (Rochelle Salt).—65s. per cwt. net for 1-ton lots. Crystals, 2s. 6d. per cwt. extra.

Sod. Salicylate.—Powder, 2s.—2s. 8d. per lb. Crystal, 2s. 1d.—2s. 9d. per lb.

Sod. Sulphide.—Pure recryst., 10d.—1s. 2d. per lb.

Sod. Sulphide anhydrous.—£23—£25 per ton, according to quantity, d/d U.K.

Strontium Iodide.—17s. 6d. per lb.

Tartar Emetic B.P.—3s. 9d.—4s. 6d. per lb.

Terpine hydrate.—1s. 2d.—1s. 5d. per lb.

Thymol, Puriss.—5s. 9d.—6s. 6d. per lb., according to quantity. Natural.—12s. per lb.

Zinc Iodide.—21s.—22s. per lb.

Zinc Stearate.—1s. 4d.—1s. 6d. per lb.

PERFUMERY CHEMICALS

Acetophenone.—7s. per lb.

Aubepine (*ex Anethole*).—8s. per lb.

Amyl Acetate.—2s. 3d. per lb. Amyl Butyrate.—4s. per lb. Amyl Cinnamic Aldehyde.—8s. 3d. per lb. Amyl Salicylate.—2s. 9d. per lb. Anethol, 21/22° C., 4s. 9d. per lb.

Benzaldehyde free from Chlorine.—2s. 9d. per lb.

Benzyl Acetate from Chlorine-free Benzyl Alcohol.—2s. per lb. Benzyl Alcohol free from Chlorine.—2s. per lb. Benzyl Benzoate, 2s. 3d. per lb.

Cinnamic Aldehyde.—Natural, 12s. 3d. per lb.

Citronellol.—8s. 6d. per lb.

Citral.—7s. per lb.

Coumarin.—15s. per lb.

Ethyl Cinnamate.—8s. 6d. per lb.

Ethyl Phthalate.—2s. 6d. per lb.

Eugenol.—7s. 3d. per lb. Geraniol (Palmarosa).—17s. per lb. Geraniol.—6s. 6d.—11s. per lb. Heliotropine.—6s. per lb. Iso Eugenol.—8s. 6d. per lb. Linalol.—(*ex Bois de Rose*) 6s. 3d. per lb.—(*ex Shui Oil*) 5s. 6d. per lb. Linalyl Acetate.—(*ex Bois de Rose*) 7s. 6d. per lb.—(*ex Shui Oil*) 6s. 6d. per lb.

Methyl Anthranilate.—9s. per lb.

Methyl Benzoate.—4s. 6d. per lb.

Musk Ketone.—33s. per lb.
Musk Xylol.—8s. per lb.
Nerolin.—5s. per lb.
Phenyl Ethyl Acetate.—10s. per lb.
Phenyl Ethyl Alcohol.—8s. 6d. per lb.
Rhodinol.—60s. per lb. Safrol.—1s. 6d. per lb. Terpineol.—2s. per lb. Vanillin (*ex Clove Oil*).—16s.—18s. per lb.—(*ex Guaiacol*)—14s. 3d.—16s. 3d. per lb.

ESSENTIAL OILS

Almond.—Foreign S.P.A., 9s. per lb. Anise.—2s. 1d. per lb. Araucaria, 8s. 6d. per lb.—Bergamot. 6s. 6d. per lb. Bourbon Geranium.—24s. 9d. per lb.
Camphor.—Brown, 70s. per cwt.—White, 75s. per cwt. Cananga, Java, 10s. per lb. Cinnamon Oil.—3s. 6d. per lb. Cassia, 80/85%, 4s. 6d. per lb.
Citronella Oil.—Java, 2s. 9d. per lb. Ceylon, 2s. 3d. per lb. Clove.—90/92% English, 4s. 9d. per lb.
Eucalyptus, Australian B.P., 70/75%.—1s. 2d. per lb. Huon Pine (Methyleugenol, 95%), 16s. per gal. Lavender.—Mont Blanc, 38/40%.—10s. 9d. per lb. Lemon.—4s. 6d. per lb. Lemongrass.—4s. 3d. per lb. Orange, Sweet.—6s. 6d. per lb. Otto of Rose.—*Anatolian, 37s. 6d. per oz.; Bulgarian, 55s. per oz.* Palma Rosa, 8s. per lb.
Peppermint.—Japanese, 6s 6d. per lb. Wayne County, 14s. 3d. per lb. Petitgrain.—4s. 9d. per lb.
Sandalwood, Mysore.—30s. per lb. 90/92%, 20s. per lb. Australian, B.P. and French Codex, 92/95%, 15s. 6d. per lb.

INTERMEDIATES

Items marked thus * d/d buyers' works.

*Acid, Benzoic, *1914 B.P. ex Toluol*.—1s. 9½d. per lb. in casks.
*Acid Gamma.—Spot, 4s. per lb., 100%.
*Acid H.—Spot, 2s. 4½d. per lb., 100%.
*Acid Neville and Winther.—Spot, 3s. per lb., 100%.
*Acid Sulphanilic, 8d. per lb.
*Aniline Oil, spot, 8d. per lb., drums extra.
*Aniline Salts, spot, 8d. per lb., casks free.
*Benzaldehyde, spot, 1s. 8d. per lb., packages extra.
*Benzidine Base.—Spot, 2s. 5d. per lb., 100%.
o-Cresol 30/31° C.—£2 6s. 5d. per cwt. in 1-ton lots.
m-Cresol 98/100%.—2s. 3d. per lb., in ton lots.
p-Cresol 34.5° C.—1s. 9d. per lb., in ton lots.
Dichloraniline.—2s. 3d. per lb.
*Dimethylaniline.—Spot, 1s. 6d. per lb., packages extra.
Dinitrobenzene.—8d. per lb.
Dinitrotoluene 48/50° C.—8d. per lb. 66/68° C.—9d. per lb.
*Diphenylamine.—Spot, 2s. per lb.
*α-Naphthol.—Spot, 2s. 4d. per lb.
*β-Naphthol.—Spot, £78 15s. per ton, in paper bags; £79 15s. per ton in casks, in 1-ton lots.
*α-Naphthylamine.—Spot, 11½d. per lb.
*β-Naphthylamine.—Spot, 2s. 9d. per lb.
o-Nitraniline.—5s. 10d. per lb.
**m*-Nitraniline.—2s. 7d. per lb.
**p*-Nitraniline.—Spot, 1s. 8d.—2s. 1d. per lb.
*Nitrobenzene.—Spot, 4½d. per lb., 5-cwt. lots, drums extra.
Nitronaphthalene.—9d. per lb.
*Sodium Naphthionate.—Spot, 1s. 9d. per lb., 100%.
**p*-Toluidine.—Spot, 1s. 11d. per lb.
**o*-Toluidine.—Spot, 9½d. per lb., drums extra.
m-Xylidine acetate, 3s. 4d. per lb., 100%.

PATENT LIST

The following is a list of complete specifications of chemical interest which are open for inspection under Section 91 (4) (a) of the Patent Acts. Printed copies are not available, but photographic copies may be obtained at a charge of 8d. per page (minimum 1s.) from the Patent Office, Chancery Lane, W.C.2

I. 269 (1933). Internat. Latex Processes, Ltd. Method of dispersing solids.
4042 (1933). Holzwarth. Producing a pressure medium.
1183 (1933). Ruhrchemie A.-G. Apparatus for carrying out gas reactions.
4438 (1933). Lange and Brasch. Examination of objects by means of X-rays.
22,458 (1933). Munters. Heat insulation.
II. 2637 (1933). Air Reduction Co., Inc. Separation of acetylene.
III. 2026 (1933). Air Reduction Co., Inc. Manufacture of alcohols.
3756 (1933). I. G. Farbenind. Manufacture of condensation products.
3904 and 4419 (1933). I. G. Farbenind. *See* IV.
IV. 3755 (1933). I. G. Farbenind. Manufacture of dyestuffs of the anthraquinone series.
3904 (1933). I. G. Farbenind. Manufacture of azo-dyestuffs and intermediate products therefor.
4025 (1933). I. G. Farbenind. Solid vat dyestuff preparations.
4419 (1933). I. G. Farbenind. Manufacture of stable diazonium compounds.
V. 4393 (1933). Houck. Manufacture of crêpe yarn.
IX. 22,458 (1933). Munters. *See* I.
X. 11,252 (1932). Krupp Grusonwerk. Distillation of readily-volatilizable metals.
36,848 (1932). Curtin-Howe Corp. Production of protective coatings on iron and steel articles.
3218—9 (1933). Oesterr. Amerikanische Magnesit A.-G. Continuous distillation of magnesium.
12,079 (1933). Krupp Grusonwerk. Distillation of readily-volatilizable metals.
XIII. *3925 (1933). Kaczkowski and Piornik.* Making hardenable plastic masses.
4024 (1933). I. G. Farbenind. Manufacture of plastic materials.
XIV. 269 (1933). Internat. Latex Processes, Ltd. *See* I.
XIX. 28,103 (1932). Swift & Co. Preparing meat products.
34,738 (1932). Endowment Foundation. Egg powders.
XX. 3912 (1933). I. G. Farbenind. Manufacture of a therapeutically-active preparation.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Australia:* Dyes and chemicals for the textile trade (169); Turbo blowers and air compressors (G.Y. 12,890). *Austria:* Raw materials, semi-manufactured goods in non ferrous metal, iron, steel, and metal goods (177); Iron and steel wares, pig iron, tinplate (179). *France:* Tin solder for use in plumbing, boiler-making, preserving, etc. (185). *Iraq and Palestine* (*Bagdad and Tel-Aviv*): Paint, varnish, linseed oil (196). *South Africa:* Chlorination plant (G.Y. 12,887).

Zinc

An interesting brochure describing the many uses to which zinc and the by-products of zinc ores are put has been issued recently by the directors of the Imperial Smelting Corporation, Ltd. to the shareholders. Copies may be obtained on application to the secretary of the Corporation, 95, Gresham Street, E.C.2.

The importance of the zinc smelting industry from an Empire view-point and its striking development in this country since the war are among subjects dealt with in a foreword by the chairman, Sir Robert Horne.

The history of zinc is dealt with in a very interesting way, and a diagram shows how zinc ore is divided into the metal, zinc dust, zinc oxide, lithopone, dross and by-products, and how these are eventually used in over a hundred industrial products such as paints, rubber goods, pharmaceutical products, dyestuff-reducing agents, batteries, wood preservatives, etc.

New I.C.I. Dyestuff

An attractive blue has recently been added by Imperial Chemical Industries to its range of acid dyestuffs with the name Lissamine Cyanine A.S. The dye is suitable for dyeing yarns and piece goods where brilliancy of shade and fairly good fastness to washing are desirable. It may be used as an illuminating colour in stannous discharge styles, and is of interest for application to vegetable tanned leathers and for use in brush staining work. It possesses good affinity for the wool fibre when dyed from a sulphuric acid bath.

Organic Reagents for Metal

Organic Reagents for Metals, which has been published this year by Hopkin & Williams, Ltd., of Hatton Garden, London, E.C.1, at a price of 1s., is not an advertisement publication for this firm's productions, except in so far as good workmanship and precise attention to the interests of the user of such products are always the best possible advertisement. This booklet, which is on the lines of a textbook, gives detailed information on the use of certain reagents which have assumed considerable importance in analytical work, but which have not yet found their way into all the standard text books, and the book will be valuable in that it can be used as a guide to the method of procedure in the laboratory. In addition it will be useful outside the laboratory as a means of carrying investigation further into the literature dealing with each of the reagents, as bibliographies are provided in each case. Some two dozen reagents are dealt with, and they have been indexed to show the metals in the detection of which the reagents are useful, and many of these methods of detection are described in detail.

Hadfields, Ltd.

The use of coal breakers is being extended by engineers, contractors, and others, for the preparation of coal suitable for use in connexion with automatic stokers, suction gas producers, and other purposes, thereby affording a much greater scope in the distribution of this very important "raw material." For this class of work Hadfields, Ltd., of East Hecla Works, Sheffield, offer four distinct types of coal breakers to suit individual requirements, particulars of which are given in a brochure recently issued by the company. The first is the "Hecla" 3-stage coal breaker, which is fitted with renewable wearing parts of Hadfield's toughened cast steel. This breaker produces the minimum of slack and the three successive crushing operations to which the coal is subjected render the machine capable of reducing coal of mine size down to ¾-in. cubes and under.

The brochure gives particulars also of the Hadfield single-roll coal breaker, in which the rotary member consists of a solid cast-iron centre with toothed crushing sectors of Hadfield's "Era" manganese-steel, the two-roll breaker and the four-roll breaker, which possess a number of good features. In addition Hadfields, Ltd., are always ready to use experience and knowledge in introducing whatever modifications are deemed necessary to meet special conditions.

PUBLICATIONS RECEIVED

QUALITITIVE CHEMISCHE ANALYSE ANORGANISCHER GEMENGE MIT EINFACHSTEN HILFSMITTELN. By Dr. G. Vortmann. Pp. 61. Berlin: Verlag Chemie, 1933. 3.60 m.

INVESTIGATIONS ON BARLEY. REPORT ON 10 YEARS OF EXPERIMENTS UNDER THE INSTITUTE OF BREWING RESEARCH SCHEME, 1922—1931. By Sir E. J. Russell, F.R.S., and L. R. Bishop, M.A., Ph.D. Institute of Brewing Research Scheme. Supplement to the Journal of the Institute of Brewing, Vol. XXXIX, No. 7 (Vol. XXX, New Series), July, 1933. Pp. 287—421. London: Harrison & Sons, Ltd., 1933.

REVIEW OF AGRICULTURAL OPERATIONS IN INDIA, 1929—30 and 1930—31. Imperial Council of Agricultural Research. A.G.—R1/31. Pp. v + 350. Delhi: Manager of Publications, 1933. 8s. 3d. or Rs. 5.

WATER SUPPLIES OF THE FEDERATED MALAY STATES. By R. W. Blair. Bulletins from the Institute for Medical Research, Federated Malay States. No. 2 of 1933. Pp. 162. Kuala Lumpur: Kyle, Palmer & Co., Ltd., 1933.

INFRA-RED PHOTOGRAPHY. By S. O. Rawling, D.Sc. Pp. x + 57. London and Glasgow: Blackie & Son, Ltd., 1933. 3s. 6d.

ORGANIC SYNTHESES: AN ANNUAL PUBLICATION OF SATISFACTORY METHODS FOR THE PREPARATION OF ORGANIC CHEMICALS. Edited by W. H. Carothers. Vol. XIII. Pp. vii + 119. New York: J. Wiley & Sons; London: Chapman & Hall, Ltd., 1933. 10s. 6d.

INORGANIC COLLOID CHEMISTRY. By H. B. Weiser. Vol. I. COLLOIDAL ELEMENTS. Pp. xi + 389. New York: J. Wiley & Sons; London: Chapman & Hall, Ltd., 1933. 28s.

METHODS FOR THE QUANTITATIVE ANALYSIS OF COAL ASH. By J. G. King, Ph.D., B.Sc., and H. E. Crossley, M.Sc., B.Sc. Department of Scientific and Industrial Research. Fuel Research. Physical and Chemical Survey of the National Coal Resources No. 28. Pp. iv + 20. London: H.M. Stationery Office, 1933. 6d.

TECHNOLOGIE DER TEXTILFASERN. Edited by Dr. R. O. Herzog. Vol. VII. KUNSTSEIDE. Revised by E. A. Anke and others. 2nd revised edition. Pp. ix + 321. Berlin: J. Springer, 1933. 31.50 rm.

REPORTS ON THE PROGRESS OF NAPHTHOLOGY, 1932. Reprinted from the Journal of the Institution of Petroleum Technologists, June and July, 1933. Pp. 427—677. London: Institution of Petroleum Technologists, 1933. 10s. 6d.